REMARKS

In the final Office Action, claims 1-36 were finally rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,543,614 to Miyamoto ("Miyamoto").

By the present amendment, independent claims 1 and 25 have been amended to incorporate the subject matter of dependent claims 13 and 32, respectively, including the subject matter of any intervening dependent claims. Dependent claims 11 and 12 have been rewritten in independent form to incorporate the subject matter of base claim 1 and any intervening claims. Dependent claims 3, 13 and 29-31 and 33 have been canceled without prejudice or admission, and dependent claims 4, 5, 14, 15, 16, 25, 34 and 35 have been amended to conform to amended claims 1 and 25.

Entry of the foregoing amendments is most respectfully requested since they do not raise any new issues or require further consideration. The amendments merely consist of the rewriting of dependent claims in independent form and revising the dependency of various dependent claims to conform therewith.

Based on the foregoing amendments, claims 1, 2, 4-12, 14-28 and 34-36 remain pending and finally rejected. Applicants respectfully submit that the pending claims patentably distinguish over the prior art of record.

Amended independent claim 1 recites a scanning probe microscope comprising a probe, means for maintaining the probe in close proximity to the sample surface, scanning means for raster scanning the probe along first and second axes and maintaining the probe in close proximity to the sample to follow undulations on the sample surface in a third axis, scanning control means for controlling relative raster scanning of the probe with respect to the sample, and displacement detection means for measuring relative position and displacement of the scanning means in the direction of the second or third axes and outputting a corresponding feedback signal for controlling the probe position.

By the present amendment independent claim 1 has been amended to further recite that the scanning control means includes scanning speed adjustment means for adjusting the speed of the raster scanning in the direction of one of the first and second scanning axes, and sampling pulse generating means for generating sampling pulses at predetermined times.

Similarly, amended independent claim 25 now recites that the scanning control means comprises scanning speed adjustment means for adjusting the speed of the scanning in the direction of the first axis so that a control error in the direction of the third axis is minimized, and sampling pulse generating means for generating sampling pulses for sampling the position of the probe at predetermined times.

Amended dependent claims 14-16 further limit the structure of the scanning control means of amended independent claim 1. Dependent claim 14 recites that the scanning speed adjustment means adjusts the relative speed of the probe with respect to the sample in the direction of the scanning axis having the higher high scanning frequency of the first scanning axis and the second scanning axis of the raster scanning so that a control error in the direction of the third scanning axis is minimized. Dependent claim 15 recites that the scanning speed adjustment means keeps constant the relative position or displacement of the probe with respect to the sample in the direction of the scanning axis having the lower scanning frequency of the first scanning axis and the second scanning axis of the raster scanning. Dependent claim 16 recites that the scanning speed adjustment means adjusts the relative speed of the probe with respect to the sample in the direction of the scanning axis having the higher scanning frequency of the first scanning axis and the second scanning axis of the raster scanning so that an absolute value of a control error in the direction of the third scanning axis is minimized.

Accordingly, amended independent claims 1 and 25 recite a scanning probe microscope having a displacement

detector and scanning control means for controlling the velocity of a scanner in order to obtain an image of a sample.

Amended independent claims 11 and 12 recite that the scanning control means controls the device such that the rate of change over time of the relative position and displacement of the probe with respect to the sample in the direction of one of the scanning axes becomes constant (claim 11) or becomes a set value (claim 12) until the probe enters a range being observed.

In a conventional scanning probe microscope (SPM), a sample is mounted to a sample stage above an XYZ translator and is brought into contact with a sharpened probe fixed to the tip of a cantilever. The sample is scanned in the XY plane by the XYZ translator. During scanning, deflection of the cantilever is monitored by a deflection detector. A controller performs feedback control so that cantilever deflection is fixed, and the position of the sample in the Z direction is adjusted by the XYZ translator.

The sample is raster scanned relative to the probe using the XYZ translator in a high frequency axis (X axis) and a low frequency axis (Y axis) while probe deflection is measured in the third axis (Z axis) to follow undulations on the sample surface. However, the scanning is distorted due to

hysteresis in the XYZ translator, which is generally formed using a piezoelectric actuator. Conventional means used to combat this problem include measuring hysteresis values prior to conducting sample measurements and using the measured values as compensation values to ensure that the amount of displacement of the XYZ translator becomes linear with respect to time.

Methods used to overcome the foregoing problem entail measuring the amount of displacement of the XYZ translator using a displacement sensor and using the detected displacement to generate an image or to perform feedback control of the probe position during scanning.

However, the above-described methods either fail to account for deterioration of component parts over time, or require an inordinate amount of data processing.

The present invention overcomes the foregoing problems and provides a scanning probe microscope which is not subject to the influence of hysteresis of a piezoelectric element or deterioration with age, which reduces the amount of data processing required, and which is capable of increasing scanning frequency band limits.

As pointed out above, amended independent claims 1 and 25 recite that the probe velocity is controlled using the displacement detector and amended independent claims 11 and 12

recite that the rate of change of probe displacement is controlled.

In accordance with the present invention, a scanning probe microscope is provided with scanning control means for controlling raster scanning of an XYZ translator and displacement detection means for detecting the amount of displacement of the XYZ translator and outputting a feedback signal based on the detected displacement for controlling the probe position. The velocity or rate of change in displacement of the XYZ translator is controlled in order to avoid errors due to hysteresis. As a result, it is possible to remove the effects of creep and drift in the direction of the lower frequency scanning axis, and the data required to generate an image is made up of relative displacement of the probe in the direction of the higher frequency scanning axis and relative displacement of the probe in the direction of the third axis, which are obtained through interpolation of data for the high frequency scanning axis, making it possible to reduce the amount of data and computation time. Thus it is possible to carry out high speed scanning by performing feedback control only in the direction of the low frequency scanning axis.

No corresponding structure is disclosed or suggested by the prior art of record.

Miyamoto was cited as disclosing an SPM comprising, inter alia, a displacement detection unit that detects displacement of a piezoelectric unit along a scan line and a matching detection unit for outputting a coincidence detection signal for maintaining such displacement at a target value.

However, Miyamoto does not disclose or suggest control of velocity or rate of change of displacement of the piezoelectric unit as required by amended independent claims 1, 11, 12 and 25.

Anticipation requires the disclosure, by a single reference, of all subject matter recited in a rejected claim. Absent disclosure of a scanning control unit for controlling velocity or rate of change of displacement of a scanning unit as required by the independent claims, anticipation cannot be found.

For the foregoing reason, applicants respectfully submit that pending claims 1, 2, 4-12, 14-28 and 34-36 patentably distinguish over the prior art of record and that the claim rejections under 35 U.S.C. §102(b) should be withdrawn.

In view of the foregoing amendments and discussion, the application is now believed to be in allowable form.

Accordingly, entry of the present amendment together with favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

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